D. S. Davidson Company

OPERATOR'S MANUAL
MODEL 2056--4K
Portable Multi—Channel Analyzer

Instrumentation
For Science
And Industry

North Haven, Connecticut • (203) 288-7324

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SECTION 1
INSTALLATION

Unpacking and Before Operation 1.1 1
Power Source 1.2 1
Environment 1.3 1
Warnings 1.4 1

SECTION 2
INTRODUCTION

INTRODUCTION 2.1 1
SPECIFICATIONS 2.2 2

SECTION 3
OPERATING PROCEDURES

LCD DISPLAY 3.1 1
  COMMAND WINDOW 3.1.1 1
  INVALID KEY WINDOW 3.1.2 1
  WARNING MESSAGES 3.1.3 1
Keyboard 3.2 2
  Command Keys 3.2.1 2
  Scroll Keys 3.2.2 2
  END Key 3.2.3 2
  Keypad 3.2.4 2
  ENTER and CLEAR ENTRY Keys 3.2.5 2
  Adjust Keys 3.2.6 2
  Question Keys 3.2.7 3
  Display Control Keys 3.2.8 3
  PRINT Key 3.2.9 3
  NEXT Key 3.2.10 3
CRT Display 3.3 4
  FULL SCALE Knob 3.3.1 4
  CURSOR Switch 3.3.2 4
  Intensified Display 3.3.3 4
  Expansion and Position 3.3.4 4
Cassette Recorder 3.4 5
  Inserting Cassette 3.4.1 5
  Care of Cassette Recorder 3.4.2 5
Power Switch 3.5 5
I/O PORT RS-232C 3.6 6
FRONT PANEL OF THE MCA 3.7 7

SECTION 4
COMMANDS

ACQUIRE Command	4.1	1
MCS Command	4.2	3
USER Command	4.3	5
SETUP Command	4.4	6
PRESET Command	4.5	11
MEMORY Command	4.6	12
PLOT Command	4.7	14
I/O Command	4.8	15
SAMPLE READ OUT	4.8.1	15a
TAPE Command	4.9	16
TAPE Errors	4.9.1	18
CALIB Command	4.10	19
CALC Command	4.11	20
ROI Command	4.12	21

SECTION 5
CONNECTORS

INPUT Connector	5.1	1
High Voltage Connectors	5.2	1
Cutoff High Voltage Connector	5.3	1
Pole Zero Test Point Connector	5.4	1
Preamplifier Power Pin Assignments	5.5	2
RS-232-C Serial Port	5.6	3
External Display and Plotter Assignments	5.7	4
Side Panel Connectors	5.8	5

SECTION 6
ADJUSTMENTS

Location of Adjustments	6.1	1
Amplifier Adjustments	6.2	1
NAI Pole/Zero Adjustments	6.2.1	1
HRG Pole/Zero Adjustments	6.2.2	1
Baseline Restorer Discharge Current	6.2.3	1
Baseline Restorer Zero Voltage	6.2.4	1
Setup for POLE/ZERO adjustment	6.2.5	1a
CRT Display Adjustments	6.3	2
Vertical Adjustment for CRT Display	6.3.1	2
Horizontal Adjustment for CRT Display	6.3.2	2
Cursor Size Adjustment for CRT Display	6.3.3	2
Twist Coil Adjustment for CRT Display	6.3.4	2
Stabilizer Adjustments	6.4	3
Stabilizer GAIN Adjustment	6.4.1	3
Stabilizer TEMPerature COMPensation	6.4.2	3

SECTION 7
CONFIGURATIONS

External control 7.1 1
Serial Handshake 7.1.1 1
Sample Software 7.1.2 2
SETUP BY EXTERNAL CONTROL 7.1.3 9
CONTROL BY EXTERNAL 7.1.4 10
DATA TRANSFER BY EXTERNAL CONTROL 7.1.5 11
MCA TO EPSON CABLE 7.1.6 12

SECTION 8
SERVICE

Service 8.1 1
In House Service 8.2 1
Replacement Parts 8.3 2

SECTION 9
OPTIONS

Auto-Cycle 9.1 1
Example Key Sequence 9.1.1 2
8K Data Memory 9.2 3
Plus and Minus 24 Volt Option 9.3 3
PLOT ON EPSON PRINTER 9.4 4
PRINTER AND CONNECTIONS 9.4.1 5
PLOT OF SPECTRUM FROM PRINTER 9.4.2 5
EFFICIENCY CALIBRATION 9.5 6
MEASURE ACTIVITY 9.6 8

1.1 Unpacking and Before Operation

Carefully inspect the unit for any possible damage and report, if any, to the carrier immediately. The container and packing materials should be saved for any future shipping. Check to make sure you received all the parts of the system which you ordered.

1.2 Power Source

It is recommended that the internal battery be fully charged before operation. First set the line voltage switch on the charger for the proper setting and plug into either a 115 or 230 volts AC line source of 50 to 60 hertz. Next throw the switch on the charger toward CHARGE BATTERY and plug the cable into the plug marked CHARGER on the MCA. When the green LED goes out the battery is fully charged. Before you turn the power on to the MCA throw the switch on the charger to OPERATE MCA.

1.3 Environment

The MCA may be operated over an ambient temperature range from 0°C to 40°C with a non-condensing humidity range from 20% to 80%. The unit may be operated in any position provided it is secured in place, normal operation requires the unit to be placed on a hard flat surface. Avoid places where static electricity is a problem.

1.4 Warnings

The operator must insure that the HIGH VOLTAGE is properly connected and used with this instrument. Misuse may result in severe shock or damage to other equipment. Service personnel should read all warning labels and respect them. There are potential hazards within the unit. The LCD display and CRT display are delicate, do not push on them or clean them with harsh substances.

2.1 Introduction

The 2056-4K MultiChannel Analyzer is a portable easy to use battery powered instrument. Designed for field use yet it is convenient and powerful in the laboratory. Data acquisition applications include, as standard, Pulse Height Analysis and MultiChannel Scaling. This instrument had its beginning at Los Alamos National Laboratory. The laboratory monitored the development at the D.S.Davidson company and then evaluated the final design. Currently special application software is being developed for the 2056-4K, which will do routine measurements once made only on larger more expensive MCA systems.

The internal battery can power the unit for 10 hours on a full charge. Tests have indicated that under real operating conditions, providing preamplifier power and high voltage to a HRG low power preamp detector and using occasionally the CRT display, cassette recorder and RS-232 port The operating time is greater than 7.5 hours at 25°C.

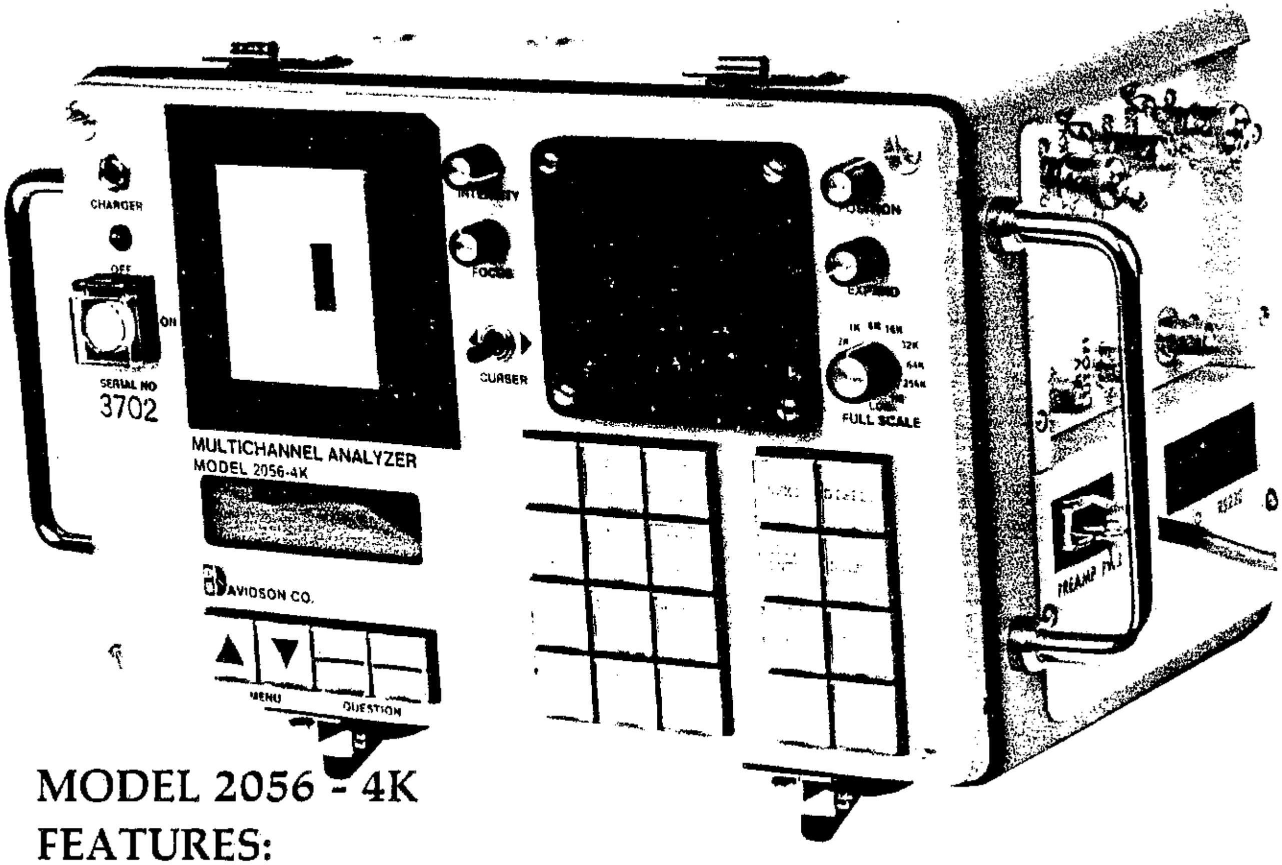
Performance in a wide range of field applications is possible with unique features such as a 100 Mhz ADC, a good low noise unipolar amplifier with active base line restorer and a pulse pile up rejector. Essential to most applications is a simple and reliable means to save data. The built in cassette recorder only requires a simple key sequence to record the entire spectrum with parameters and ROI information. Different detector and I/O configurations are easy since no internal strapping is required. All parameters are selectable by the keyboard or read from tape. You need never remove the internal electronics from the box, all the necessary adjustments are accessible by removing the side cover.

The internal CRT provides enhanced analysis of spectra with resolution of 2048 by 256, four intensities, digital and analog expansion with roll, automatic power down after 4 minutes and twinkle during acquisition for locating activity.

Provisions for external control using the RS-232 port are included as standard. The new battery operated computers will provide you with a powerful means of data reduction on site. Virtually all the functions of the MCA are controllable making it a portable turnkey system.

NEW PRODUCT NEW PRODUCT

Portable Multi-Channel Analyzer



MODEL 2056 - 4K

FEATURES:

- ☐ 100 MHz ADC
- ☐ 4096 Channels
- ☐ Spectroscopy Amplifier
- ☐ Active Base Line Restorer
- ☐ Pulse Pile Up Rejector
- ☐ Multi-Channel Scaler
- ☐ Real-Time Clock
- ☐ 3 Detector HV Power Supplies
- ☐ Live CRT Display
- ☐ LCD Display
- ☐ Digital Data Casette Recorder
- ☐ RS 232C Serial Interface
- ☐ Optional:
  8K Data Memory
  Auto Cycle
- ☐ User Friendly
- ☐ Data Analysis:
  Energy Calibration
  Automatic Peak Search
  Peak Energy and Net Area
  User Programs
- ☐ Rechargeable 12 Volt Battery

Davidson Co.
19 Bernhard Road • North Haven, CT 06473 • (203) 288-7324 • Telex 703410

TECHNICAL SPECIFICATIONS
MODEL 2056 - 4K
PORTABLE MULTI-CHANNEL ANALYZER

LINEAR AMPLIFIER

INPUT:	Voltage sensitive
GAIN RATIO:	1 to 16383
PULSE SHAPING:	Unipolar 1 or 3 µseconds, each with Separate P/Z Adjustments
RESTORATION:	Active Base Line Restorer
PULSE PILEUP REJECTION:	Selectable

ADC

INPUT:	4.096 volts positive, Direct or Amplifier
CONVERSION RATE:	100 MHz Wilkinson ramp.
CONVERSION GAIN:	4096, 2048, 1024, 512 Channels FS
INTEGRAL NON LINEARITY:	± .025% over top 99% FS
DIFFERENTIAL NON LINEARITY:	± 1% over top 99% FS
ZERO DRIFT:	± .0025%/deg. C
GAIN STABILITY:	± .01%/deg. C
PEAK SHIFT:	± .025% at rates to 50 KHz
DEAD TIME:	(10ns x N) + 2 µseconds
PROCESSING:	Fully preprocessed and buffered in separate ADC memory to minimize main processor busy time.

DETECTOR HIGH VOLTAGE POWER SUPPLY

RANGE:	0 to 1250 volts for NaI, Positive External HV Cutoff 0 to 5000 volts for Germanium Positive and Negative
REGULATION:	± .05%/deg. C
STABILIZATION:	BNL Americium doped NaI Detector Circuit for Gamma Ray Spectra stabilization.

DATA ACQUISITION AND CONTROL

COUNT CAPACITY:	$2^{24} - 1$ (16,777,215) per channel
STORAGE MODES:	PHA add
PRESETS:	Live Time, Counts in Channel, Integral of ROI, Net Counts in ROI

DISPLAY

CRT DISPLAY:	7 cm linear and log spectrum
CONTROL:	Expansion, Roll, Cursor, On, Off
RESOLUTION:	2048 by 256 fully buffered
DISPLAY MEMORY:	2048 by 16 CMOS SRAM
LCD DISPLAY:	2 rows of 16 characters each for channel counts, presets, instructions and diagnostics

KEYBOARD

	24 Keys with positive Tactile feed back
FUNCTIONS:	Control, Parameter selection Data entry, Data Analysis

PROCESSOR, MEMORY, and ANALYSIS FUNCTIONS

TYPE:	MOTOROLA 6809 Processor based
MAIN MEMORY:	16K bytes CMOS SRAM 56K bytes CMOS PROM
DATA CHANNELS:	4096, 2048, 1024 or 512 (8192 optional)
DATA ANALYSIS:	Overlap, ROI Integrals, Net Area, Spectrum Strip, Energy Calibration, Automatic Peak Search
SPECIAL PROGRAMS:	Provided in CMOS PROM as required by user
REAL TIME:	Provides year, month, day, hour and minute for data logging.

DATA RECORDER

TYPE:	Digital phase-encoded magnetic cassette recorde built in
CASSETTE:	Mini Data Cassette, certified
FORMAT:	Spectrum identifier, instrum parameters, data
TIME:	40 seconds for 4096 chann spectrum
CAPACITY:	10 spectra per cassette (80
CONTROL:	Rewind, Select Side A or B, W Read, Skip File, Back File

DATA I/O PORT

SERIAL:	EIA RS-232C
BAUD RATES	110 to 19,200

PHYSICAL CHARACTERISTICS

SIZE:	7" x 11" x 9" (178x279x229mm
WEIGHT:	15lbs. (6.7kg)
POWER:	Internal 12 volt rechargeab Gel Cell Battery
CHARGER:	105V to 130V, or 210V to 26 50 to 400 Hz
DC SUPPLY:	10V to 14V from external battery pack or charger

MCS

COUNT RATE:	100K counts per second
DWELL TIME:	1 MS to 9000s per channel

*The data given in this sheet are subject to change without notice.

3.1 LCD DISPLAY

The Liquid Crystal Display, referred to as LCD, is the device used by the MCA to communicate with you such things as system status, key entries needed, messages and parameters. By observing this window you can always tell what the MCA is doing.

3.1.1 COMMAND WINDOW

```
CH 2013=   17848
PUSH COMMAND KEY
```

The main window is the command window, press the END key until it appears, it directs you to push a command key located as the top label on the keypad (3x4 array) also it displays the cursor channel with counts.

3.1.2 INVALID KEY WINDOW

```
INVALID KEY
PUSH VALID KEY
```

If you happen to press a wrong key which is invalid the MCA will flash the above message.

3.1.3 WARNING MESSAGES

DISCONNECT BATTERY CHARGER	battery voltage > 14.0
BATTERY LOW CONNECT CHARGER	battery voltage < 10.5
BATTERY LOW!! * LAST WARNING *	battery voltage < 10.0 HIGH VOLTAGE is turned off.
INTERNAL VOLTAGE OUT OF RANGE	+5v, +12v or -12v fault

The internal voltages are monitored about every 15 seconds. When they are within tolerance the LED on the front panel will be off or green if the battery is between 13.8 and 14.0 volts. When a fault is detected the LED will turn red and the appropriate error message flashed.

3.2 Keyboard

The Keyboard is arranged as three arrays of keys which are used to initiate commands, enter numbers, scroll through the menu, answer questions, adjust numbers and select parameters.

3.2.1 Command Keys

The Command keys are located as the top label on the keypad (3x4 array). They are valid when the lower line of the LCD window reads PUSH COMMAND KEY. To do any task you first press a command key.

3.2.2 Scroll Keys

The Scroll keys are the up and down arrow keys below the LCD display. They are valid when ever an up arrow, down arrow or up/down arrow appears in the lower right of the LCD window. When a command is selected the Scroll keys allow you to view different entries of the menu.

3.2.3 END Key

The END key is used after a command is finished to return back to the command window. Also it terminates tasks which you wish to stop, except with the cassette recorder.

3.2.4 Keypad

The Keypad contains the numbers 0 thru 9, decimal point and a change SIGN key. When the LCD cursor flashes below a numeric value these keys are used to enter a new value.

3.2.5 ENTER and CLEAR ENTRY Keys

The ENTER key registers the value into memory and moves the LCD cursor to the next value on the window. The up arrow, down arrow or END keys will also register the value. The CLEAR ENTRY key resets the value, so if you made an error it is easily corrected.

3.2.6 Adjust Keys

The Adjust keys are INC for increase and DEC for decrease located below the LCD display. While the command window is on the LCD display these keys are in parallel with the CURSOR switch used to move the cursor. The two main functions for these keys are adjusting integer values and selecting parameters. You will have to experiment with these keys to fully understand their use.

3.2.7 QUESTION Keys

The Question keys are the YES and NO keys located below the LCD display. These keys are valid only when the LCD shows a question with the cursor below the question mark "?", use these keys for the answer.

3.2.8 Display Control Keys

The three Display Control Keys are DISPLAY, NORMAL and EXPAND. The DISPLAY key turns the power on or off to the CRT display a message is give on the LCD indicating the current state. The NORMAL key cause the entire spectrum to be displayed and the EXPAND key expands the display about the cursor.

3.2.9 PRINT Key

The PRINT key outputs to the RS-232 port the characters in the LCD window. The BAUD rate and parity must be selected first using the SETUP command. For documentation purposes any window may be printed on a terminal or printer. Special characters which are not printable are replaced or made spaces.

3.2.10 NEXT Key

The NEXT key is valid when a small NX symbol appears in the lower right corner of the LCD window. This key is required when the unit needs a decision or action.

3.3 CRT Display

The MCA displays spectral data on the internal CRT display. Power for the display is toggled on or off by the DISPLAY key. Additionally, to conserve power the display shuts off after about 4 minutes. This type of display is easy to use, shows accurately spectral features, is simple in design and low on power consumption which makes it ideal for use in such a small instrument. The unique features of this display combined with the good count rate performance of the unit will probably save you much time and prove to be a pleasure to work with once in the field.

3.3.1 FULL SCALE Knob

The FULL SCALE knob selects the vertical range from 256 to 1M (2^20) counts or LOG scale. Select the desired setting and the display will be updated quickly or as soon as possible if the unit is doing a task.

3.3.2 CURSOR Switch

The cursor is controlled by the CURSOR switch push it in the desired direction. The cursor channel will have a little intensified line above it on the CRT display, the channel and counts can be read from the command window.

3.3.3 Intensified Display

The internal CRT display has four levels of intensity which provide for enhanced analysis of spectra. The channels within the Regions Of Interest are intensified, the cursor is intensified and during acquisition the data channel being incremented is intensified when the expand function is off.

3.3.4 Expansion and Position

The CRT display provides both digital and analog expansion and position. Until you have become more familiar with the unit it is easier to use one or the other. First setup the display as follows press the DISPLAY key to turn the CRT on, press the NORMAL key to display the entire spectrum, adjust the INTENSITY and FOCUS knobs for desirable levels and then adjust the POSITION and EXPAND knobs such that the trace fills the screen. Next acquire a spectrum and with the POSITION knob move a peak into the center of the screen use the EXPAND knob to examine the peak in more detail return the knobs back to the proper position. Now try the digital expansion, using the CURSOR knob place the cursor on the center channel of a peak and press the EXPAND key to examine it in more detail. Press EXPAND again to further reduce the number of channels and try moving the cursor and observe how the display rolls once you let go.

3.4 Cassette Recorder

The built in digital cassette recorder is located on the upper left of the front panel. It uses the Manchester phase encoding scheme which gives reliable results with a bit rate of 2400 per second. Essential to most field applications is a simple means for saving and logging data. All that is required is to insert a tape and then do a simple key sequence the entire spectrum with parameters, ROI information, time, date, and presets are recorded for future analysis.

3.4.1 Inserting Cassette

To insert a cassette first press the button on the recorder, the door will pop open, place the cassette with side A up and the tape window toward the left into the door, next close the door firmly without force until it latches.

Warning: Never try to remove a cassette or turn the unit off while a tape operation is in progress or data maybe lost.

3.4.2 Care of Cassette Recorder

Use only certified Digital Mini Cassettes. Extreme care should be used when you remove a cassette check to make sure the tape did not pull out and immediately place the tape back into its protective box. The user should clean the head with isopropyl alcohol and a cotton swab applicator as needed. This is determined by observation or data errors. It is advisable to change the tape whenever data recovery problems occur. If data problems persist, clean the head again.

Warning: Never allow the cassette recorder to grind, if a tape jams turn the power off and discard that tape.

3.5 Power switch

The power switch is located on the left side of the front panel and is marked OFF-ON. Turn the power ON by pushing on the switch until it engages and the internal light is lit. The LCD will display the command window and the CRT will remain off until the DISPLAY key is pushed. Turn the power OFF by pushing on the switch and then releasing it. The LCD and CRT displays will go blank.

3.6 I/O PORT RS-232C

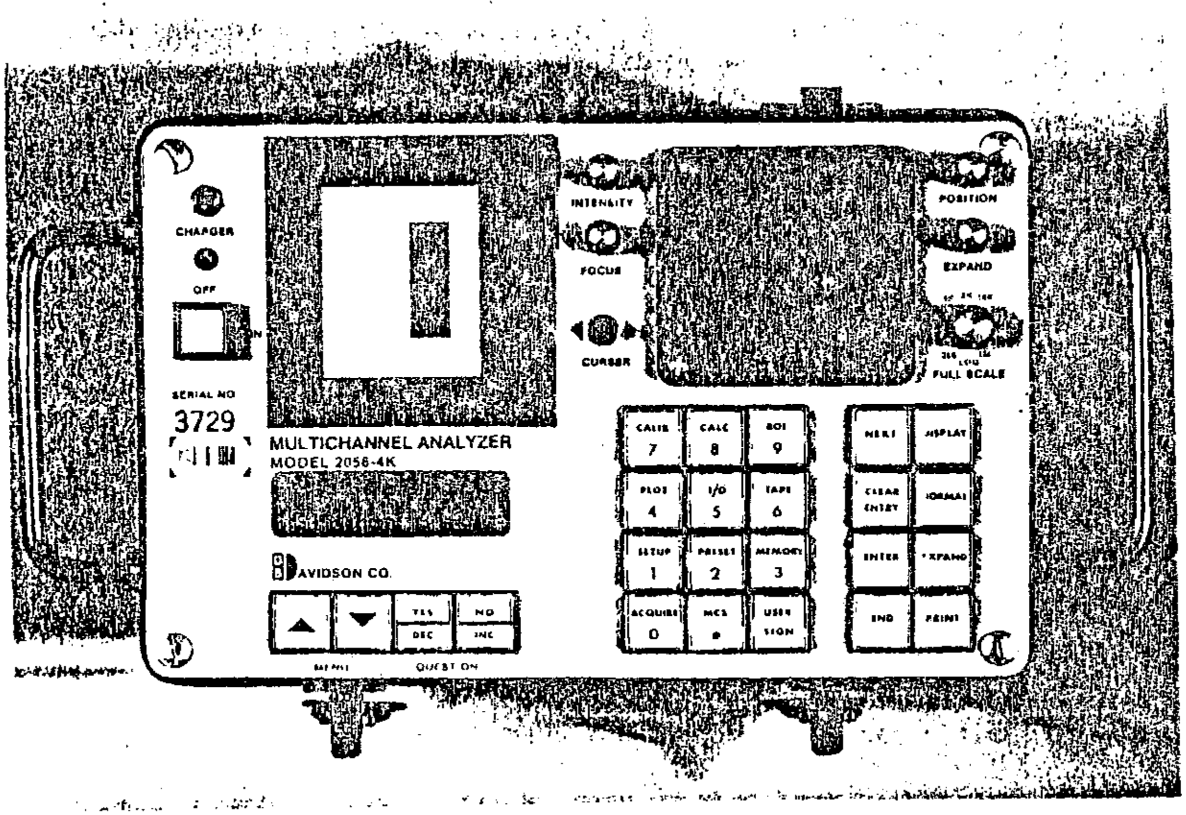
The serial port is available to connect external devices to the MCA. The port is a standard two-way RS-232C and can be connected to computers, printers, modems and terminals. For additional information see sections 4.4, 4.8, 5.6 and 7.1.

The serial port is interrupt driven and normally active all the time, except during a tape operation. The output buffer is 50 characters long and the input buffer is 80 characters long. If you send to many characters and overflow the input buffer data will be lost.

The serial port supports XON/XOFF handshake protocal. The MCA stops data transfer when XOFF ($13) is received and continues when XON ($11) is received. The MCA will not respond to the keyboard if XOFF is received and the output buffer is full.

The serial port of the external device is to be configured as below:

```
      1   START BIT
      7   DATA BITS   -ASCII CODE
 0 OR 1   PARITY BIT  -ODD, EVEN OR NONE
 1 OR 2   STOP BITS   -2 FOR 110 BAUD, 1 FOR OTHER BAUD RATES
```



Front-panel controls on the Davidson Model 2056-4K multichannel analyzer.

4.1 ACQUIRE Command

The ACQUIRE command collects data in the pulse height analysis mode. The events of the signal are digitized by the ADC to form a pulse height spectrum. Live time is generated by counting the time the ADC is able to accept an event. Connect the signal to the INPUT connector on the right hand side of the MCA. Use the SETUP command to select the desired amplifier and ADC parameters.

```
HIGH VOLTAGE NOT
ON, ENTER SETUP
```

Upon entering the ACQUIRE command a check is made to ensure that the HIGH VOLTAGE is set to the selected value. If not the above message is displayed. Push the END key then use the SETUP command to set the HIGH VOLTAGE.

```
CLEAR DATA ?
TIME=   100 S
```

The current live time is displayed in seconds or minutes on the second line. If you want to clear the data and live time push the YES key, if not push the NO key to start data acquisition.

```
ARE YOU SURE ?
```

Push the YES key to clear the data and live time. The data acquisition is started. As a safeguard against accidentally clearing data push the NO key.

```
NAI STABILIZING
WAIT ONE MINUTE
```

The stabilizer requires one minute to reach stabilization. This window will be displayed until the one minute timer times out and then data acquisition will start. Push the NEXT key to start acquisition and bypass this window.

```
CH  200=     2743
  104S   782C/S
```

The top line displays the cursor and counts in the cursor channel just as the command window does. The second line shows the remaining live time for data acquisition in seconds or minutes. When the remaining time reaches zero or the preset events in a ROI occurs the acquisition is ended. The SETUP command can be used to adjust the amplifier and ADC parameters, the twinkle display gives you an immediate indication of the changes.

```
CH  200=     2743
    96S      8%DT
```

This window is similar to the one above, except the second line which has the current live time and the percent dead time. The percent dead time is calculated from the following equation for each second interval.

%DT= (REAL TIME - LIVE TIME)/REAL TIME * 100

```
COUNT COMPLETE
TIME=   200 S
```

Count complete message that signals a preset condition has occurred and acquisition has ended. The current live time is displayed on the second line. Push the END key to return to the command window.

```
REMOTE SHUTDOWN
DETECTOR WARM
```

The liquid nitrogen for the detector has run low. The HIGH VOLTAGE is turned off and acquisition is ended. See CONNECTORS SECTION 5.3 for details on the detector circuitry required. Push the NEXT key for the previous window.

4.2 MCS Command

The MCS command acquires data in the multichannel scaling mode. Transitions of the signal through a level are counted for each time interval. The number is then added to the next data channel. Connect the signal to the INPUT connector on the right side of the MCA. Select the DETECTOR type with the SETUP command. On DIRECT input the signal is compared with the LLD and has a range from 0 to 4 volts. On HRG or NAI the signal is amplified relative to the GAIN and POLARITY settings then before the integrator is compared with the THRESHOLD.

```
CLEAR DATA ?
SWEEPS=      1
```

The number of sweeps for the last acquisition is displayed on the second line. If you want to clear the data and the number of sweeps push the YES key, if not push the NO key.

```
ARE YOU SURE ?
```

Push the YES key to clear the data and the number of sweeps. As a safeguard against accidentally clearing data push the NO key.

```
MCS DWELL TIME
=1 E 3 MILLISEC
```

Select the dwell time for MCS, first enter the digit 1 to 9 then the multiplier 0 to 6. The dwell time is equal to digit*10^multiplier milliseconds. There is a 10 microsecond dead time between each interval. On the shorter dwell settings the CRT display is unable to keep up, ignore the awkward looking display.

```
NUMBER OF SWEEPS
=     1
```

Select the number of sweeps to be completed. A sweep is complete after the last data channel is used, the next data channel being zero.

```
START MCS ?
```

To start data acquisition in the MCS mode push the YES key.

```
SWEEPS=      1
COUNT=     1220
```

Displays the number of sweeps completed and the transitions counted for a dwell interval.

```
SWEEPS=      2
MCS COMPLETE
```

The preset sweeps have been completed or the END key was hit. Push the NEXT key to collect more data or the END key to return to the command window.

4.3 USER Command

The USER command calls the optional AUTO-CYCLE or special user programs.

```
NO FUNCTION
ASSIGNED TO KEY
```

No user programs are in the MCA.

4.4 SETUP Command

The SETUP command is used to examine and change the MCA parameters. Before using the ACQUIRE command the amplifier and ADC parameters should be selected.

```
PLUS  12= 12.0V
MINUS 12=-11.9V
```

Monitors the plus and minus 12 volt power supplies. These voltages are used internally and are provided on the PREAMP connector (Section 5.5). If the voltages are reduced when the connector is used you are drawing to much external current. With the optional plus and minus 24 volts another similar window is provided to monitor these voltages.

```
BATTERY= 13.8V
PLUS 5 = 5.0 V
```

Monitors the battery voltage and the internal 5 volt power supply. With the battery charger properly connected a fully charged battery will read 13.8 volts. The normal operating battery voltage is from 10.5 to 13.8 volts. The battery voltage will drop fast during the last hour of use.

```
CHECKSUM=40335
VERSION= 1.5
```

Provides the version number of the system software and a checksum of the memory. The checksum number should be written down, if it changes there is an internal memory problem and the MCA should be returned for repair.

CHECKSUM= ____________________

VERSION= ____________________

```
PARITY=EVEN
NONE/EVEN/ODD
```

Select the parity bit for the RS-232-C serial I/O port. It must match the setting of the external device for proper operation.

```
BAUD RATE=  300
 110 TO 19200
```

Select the rate for the RS-232-C I/O port. It must match the setting of the external device.

```
13:24   2/ 2/84
SET ?  MO-DY-YR
```

The current time and date in 24 hour format. To set the clock push the YES key. Push the UP, DOWN or END keys to set the clock to the selected time and date.

```
DETECTOR=NAI
HRG/NAI/DIRECT
```

Select the type of detector. For HRG (High Resolution Germanium) detectors a 3 usec shaping time constant for the internal amplifier is used and for NaI (Sodium Iodine) detectors a 1 usec shaping time constant is used. DIRECT input is used with an external amplifier with a 0 to 4 volt output signal.

```
AMP POLARITY=POS
POS/NEG
```

Select the polarity of the internal amplifier to POSitive or NEGative. This setting must match the INPUT signal or erroneous results will occur.

```
AMP GAIN=  500
 0 TO 16383
```

Select the relative gain for the internal amplifier. The absolute gain is a combination of a course gain, a fine gain, and a fixed gain. The course gain is from 1 to 64 see TABLE 4-1 on the next page. The fine gain is from .500 to .999. The fixed gain is 20.

AMP GAIN RANGE	COURSE GAIN	ABSOLUTE GAIN
8192 to 16383	64	640 to 1278.72
4096 to 8191	32	320 to 639.36
2048 to 4095	16	160 to 319.68
1024 to 2047	8	80 to 159.84
512 to 1023	4	40 to 79.92
256 to 511	2	20 to 39.96
0 to 255	1	10 to 19.98

TABLE 4-1 ABSOLUTE GAIN

```
HVPS=     0 VOLTS
 0 TO 1250   OFF
```

Select the desired high voltage. For NAI detectors there is a range from 0 to 1250 positive volts plug the high voltage cable from the detector into the SHV connector marked 0 to 1.25KV on the right side of the MCA. For HRG detectors there is a range from 0 to 5000 positive or negative volts plug the high voltage cable from the detector into the SHV of the proper polarity marked POSITIVE 0 TO 5KV or NEGATIVE 0 TO 5KV on the right side of the MCA. The state (ON or OFF) of the high voltage power supply appears in the lower right of the LCD window.

***** WARNING ***** PLEASE READ BEFORE APPLYING HIGH VOLTAGE

The operator must make sure the high voltage is properly connected and used with this MCA. Connect only to one SHV connector and use the two protective covers on the unused SHV connectors. Extreme care must be used since all three connectors have high voltages applied and residual high voltages may remain for several minutes after the power is turned off. Misuse of the high voltage may result in severe shock !

```
SET HVPS=  600 ?
CHECK HV CABLE
```

As a safeguard this window asks for verification of the high voltage setting. To turn the high voltage on to the desired setting push the YES key.

```
CONNECT NAI
DETECTOR  PUSH Nx
```

After you have made sure the high voltage cable is connected to the proper SHV connector push the YES key to turn the high voltage on. This window is displayed once after the power to the MCA is turned on or after the detector type is changed.

```
TURN OFF
HIGH VOLTAGE ?
```

To turn the high voltage off and keep the high voltage setting PUSH the ENTER key on the HVPS window then push the YES key.

```
    HIGH VOLTAGE
↑↑↑      ON      ↑↑↑
```

A message indicating the high voltage is ramping up to the selected setting. The high voltage is increased 100 volts per second.

```
STABILIZER=ON
ON/OFF
```

Select the stabilizer to be on or off. Used for temperature stabilization with Americium doped NaI detectors. The high voltage is controlled to provide gain adjustment.

```
MONITOR=    5
HVM= 650 V
```

Monitors the relative error from the stabilizer circuitry and the high voltage at the SHV connector. For best results the MONITOR should be near zero, you will need to adjust the high voltage setting to do this.

LLD= 50
0 TO 4095

Select the Lower Level Discriminator setting for the ADC. The input signals below this level are rejected. The setting approximates the channel number.

ULD=4095
0 TO 4095

Select the Upper Level Discriminator setting for the ADC. The input signals above this level are rejected. The setting approximates the channel number.

ZERO LEVEL= 0
-127 TO 127

Select an offset to the ADC zero level. This setting is normally adjusted such that zero energy corresponds to channel zero.

THRESHOLD= 50
0 TO 255 14

Select the threshold level. On the lower right of the LCD display is the counts per second above this level. This level is normally set just above the noise. With a detector connected and operating remove the source. Locate the threshold setting with the maximum counts per second increase this setting until the counts per second drops to near zero. This level is used by the pulse pile up rejector and count rate meter circuits to determine valid events.

P.U.REJECTOR=ON
ON/OFF

Turn the pulse pile up rejector on or off. When two events are separated by less than a predetermined time interval, they are sensed as overlapping and both events are rejected.

4.5 PRESET Command

The PRESET command is used to select the conditions for ending an acquisition of data with the ACQUIRE command. The ACQUIRE command will display a COUNT COMPLETE message when the conditions are met.

PRESET LIVE TIME
= 5000 SECONDS

Select the preset time using the keypad. Push the ENTER key and select the units as SECONDS or MINUTES. Push the ENTER key again and use the INC and DEC keys to select LIVE or REAL time. Real time is only displayed thru the I/O command using an external device. when a preset on time has occurred the selected preset time, LIVE or REAL will be accurate the other will be within +1 of a unit. If a preset on a ROI is desired set the preset time to a value higher than expected.

PRESET ROI# 1

Enter the desired Region Of Interest (ROI) to preset on. If no preset on a ROI is desired enter an undefined ROI, example ROI# 0.

PRESET EVENTS
A= 100000

Enter the number of events to preset on for the PRESET ROI#. Push the ENTER key and select area (A) or integral (Σ) of the ROI.

4.6 MEMORY Command

The MEMORY command is used to select the memory group, enable overlap display, do spectrum stripping and do spectrum smoothing. The memory group defines the memory used by all the other commands. The ADC conversion gain is equal to the memory group size. For information on the optional 8K data memory see section 9.2.

```
MEMORY= 1 OF 2
OVERLAP = 2
```

Enter the desired memory group, number of groups, and the overlap memory group. The overlap memory group is displayed simultaneously with the memory group on the CRT, also it selects the other group for spectrum stripping. Set the overlap memory group to 0 to display only the memory group.

NUMBER OF GROUPS	CHANNELS
1	4096
2	2048
4	1024
8	512

```
STRIP FACTOR
=-1.5
```

Enter the strip factor from the keypad.

```
DO STRIP ?
```

Asks the question to perform spectrum stripping, push the YES key to begin. The stripping is done channel by channel, the data in the OVERLAP memory group is multiplied by the STRIP FACTOR and then added to the memory group. By selecting the OVERLAP memory group equal to the memory group spectrum normalization using the STRIP FACTOR is provided. When the OVERLAP memory is 0, stripping uses the same memory group or with the optional 8K data memory the corresponding alternate memory.

ADD STRIP
FACTOR ?

Push the YES key to add the STRIP FACTOR to the data in the memory group. This feature is useful when using overlap to observe two spectrum one of which can be offset by the STRIP FACTOR.

DO SMOOTH ?

Asks the question to perform spectrum smoothing, to begin push the YES key. Smoothing provides a three point least squares fit to a straight line. Smoothing a second time provides a five point least squares fit to a straight line.

4.7 PLOT Command

The plot command controls an external X-Y plotter. See section 5.7 for connections and signals.

PLOTTER ADVANCE
= 1000 MILLISEC

Enter the default time out for the plotter advance. If the PLOT COMPLETE signal is held low for this amount of time, the next point will automatically be generated.

START PLOTTER ?

Asks the question to start the plot, push the YES key to begin. The data as displayed on the CRT is plotted. Use the full scale knob, the NORMAL AND EXPAND keys, and the memory group to setup the plot.

4.8 I/O Command

The I/O command provides input and output of spectral data or output of the Region Of Interest information. Data transmission is by the RS-232-C port, the BAUD rate and PARITY must be properly selected using the SETUP command.

OUTPUT ALL
CHANNELS ?

Asks the question to output the channel contents, push the YES key to begin.

INPUT ALL
CHANNELS ?

Asks the question to input the channel contents in the format which is outputed above, push the YES key to begin.

OUTPUT ROI ?

Asks the question to output the ROI information, push the YES key to begin.

OUTPUT ROI AND
CHANNELS ?

Asks the question to output the ROI information and the channel contents within the boundaries, push the YES key to begin.

```
10:32    01/14/85    ID=0
LIVE TIME=435 S     REAL TIME=447 S     MEMORY= 1 OF 1

DETECTOR=HRG          LLD=50
AMP POLARITY=POS      ULD=4095
AMP GAIN=1000         ZERO LEVEL= 0
HVPS=3501 VOLTS       THRESHOLD=40
STABILIZER=OFF        P.U.REJECTOR=OFF

CH   0      0      0      0      0      0      0      0      0
CH   8      0      0      0      0      0      0      0      0
CH  16      0      0      0      0      0      0      0      0
CH  24      0      0      0      0      0      0      0      0
CH  32      0      0      0      0      0      0      1      0
CH  40     10     31     81    168    211    189    277    398
CH  48    343    274    295    279    298    248    253    200
CH  56    218    263    299    304    280    305    326    349
CH  64    268    284    273    250    245    222    208    166
CH  72    151    174    156    161    153    166    159    149
```

```
10:32    01/14/85    ID=0
LIVE TIME=435 S     REAL TIME=447 S     MEMORY= 1 OF 1

ROI# BEG   END   MAX   ENERGY(KEV)      INTEGRAL         AREA  UNCERTAINT
 1   3103  3126  3116      1173.21         24571     23323.00           17
 2   3524  3549  3537      1332.56         21077     20687.00           15
```

```
10:33    01/14/85    ID=0
LIVE TIME=435 S     REAL TIME=447 S     MEMORY= 1 OF 1

ROI# BEG   END   MAX   ENERGY(KEV)      INTEGRAL         AREA  UNCERTAINT
 1   3103  3126  3116      1173.21         24571     23323.00           17

CH3103     74     78     97    156    163    212    274    404
CH3111    753   1254   1860   2780   3617   3728   3335   2405
CH3119   1658    882    409    176     84     63     53     56

ROI# BEG   END   MAX   ENERGY(KEV)      INTEGRAL         AREA  UNCERTAINT
 2   3524  3549  3537      1332.56         21077     20687.00           15

CH3524     39     51     49     82    105    132    176    315
CH3532    472    773   1291   1956   2637   3047   2985   2659
CH3540   1935   1015    609    298    136     42     15     17
CH3548      6      5
```

4.9 TAPE Command

The TAPE command controls the built in cassette recorder. The recorder is an integral part of the system and provides such features as rewind, write file, read file, skip file, and back file. Full error processing is provided including a checksum which is stored with the data.

```
REWIND ?
SIDE=A
```

To rewind the cassette tape push the YES key. The tape is positioned at the first file location. The currently selected tape side is shown on the lower line, to change sides you must first rewind the cassette tape.

```
CASSETTE SIDE=A
A/B          Nx
```

Select the desired side using the INC and DEC keys, then push the NEXT key to return back to the TAPE command.

```
WRITE FILE ?
```

If the tape is properly positioned push the YES key to write a file. A file contains the time, date, parameters, ROIs, ID,file number, and spectrum.

```
ID=     139
FILE=     2
```

Enter the desired ID and FILE numbers, then push the NEXT key when you are ready to write the file. If you don't want to write a file push the END key to return to the command window.

```
WRITING
FILE      2
```

This message is displayed during the write operation. The MCA is not responsive during a tape operation. You will have to wait until it finishes before pushing any keys. The file number is incremented after a successful write.

```
READ FILE ?
```

If the tape is positioned at the file to be read push the YES key. The spectrum will be entered into the data memory, all other data will be placed into a buffer.

```
READING
FILE       2
```

This message is displayed during a read operation the file number is filled in after it is read from the start of the file.

```
FILE      2 NOW
IN MEMORY
```

A successful read of a file has occured. Push the down arrow to examine some of the parameters read from tape. The time and date are not available again, you may want to write them down or use the PRINT key.

```
12:36     1/27/84
ID=       139
```

The current time, date and ID when the file was created.

```
TIME=    100 S
MEMORY=1 OF 1
```

The current live time and memory group when the file was created.

```
ENTER THE TAPE
PARAMETERS ?
```

Press the YES key to setup the MCA from parameters read from the tape, enter the ROI list, set the LIVE time and set the REAL time. The HIGH VOLTAGE is turned off, you must use the SETUP command to set to the proper voltage. The BAUD RATE and PARITY are not set until the SETUP command displays the windows or the unit is powered up, this permits an external device to communicate properly with the MCA. If you don't wish to enter the parameters push the NEXT key.

SKIP FILE ?

Push the YES key to skip the next file. By keeping track of the files you may position the tape at the start of any file by using the skip and back tasks.

BACK FILE ?

Push the YES key to back up to the previous file on the tape. If an error occurs during a read you can back up to the start of the file and try again.

4.9.1 Tape Errors

Full error processing is provided including a checksum. When a tape error is detected one of the following messages will be displayed. Push the YES key to continue with the TAPE command or the END key to return back to the command window.

ON LEADER CONTINUE ?	Found the end of the tape.
NO CASSETTE CONTINUE ?	No cassette in drive.
WRITE PROTECTED CONTINUE ?	Write protect is enabled on the tape.
NO DATA FOUND CONTINUE ?	The next file was not found before the time out.
CHECKSUM ERROR CONTINUE ?	The checksums do not match.
WRONG MEMORY CONTINUE ?	Use the MEMORY .COMMAND to select the proper size.

4.10 CALIBrate Command

The CALIBrate command converts the channel number to its corresponding energy in KEV. The two point energy calibration determines the intercept (KEV at channel zero) and slope (KEV per channel), to make a fit to a straight line.

```
CH 2664=    11762
E= 662.00   KEV
```

The channel with its counts and the corresponding energy in KEV. The energy is determined by: E=SLOPE*CHANNEL+INTER.

```
SLOPE= .2485184
INTER=-.0529432
```

Displays the calibration constants SLOPE and INTERcept.

```
LEFT PEAK= 133
E= 33       KEV
```

Place the cursor on the desired low energy channel, then enter the energy in KEV for this channel.

```
RIGHT PEAK=2664
E= 662      KEV
```

Place the cursor on the desired high energy channel, then enter the energy in KEV for this channel.

```
DETERMINE SLOPE
AND INTERCEPT ?
```

Push the YES key to determine the slope and intercept from the points entered above.

4.11 CALCulate Command

The CALCulate command presents the ROI information. The integral, area, and energy is determined for each ROI. The currently selected ROI is flagged on the CRT by the cursor, which is placed on the maximum channel contents within the boundaries. The CRT display features may then be used to examine the ROI in detail.

```
ROI# 4  316  361
Σ=     6139±78
```

The first line has the current Region Of Interest number, the beginning channel, and the ending channel. The second line has the integral counts with one standard deviation.

```
ROI# 4  316  361
A=5341.667±111
```

The first line has the current Region Of Interest number, the beginning channel, and the ending channel. The second line has the area counts with the uncertainty. The area is calculated by subtracting from the integral a straight line background, which is determined by three channels outside each side of the region.

$$\text{AREA}=\Sigma-N(BL+BH)/6$$

$$\text{UNCERTAINTY}=\sqrt{\Sigma+[(BL+BH)(N/6)\text{^}2]}$$

N=Number of channels in region
BL=Sum of counts in low energy background
BH=Sum of counts in high energy background

```
ROI# 4  316  361
E= 32.94    KEV
```

The first line has the current Region Of Interest number, the beginning channel, and ending channel. The second line has the energy in KEV for the channel with the maximum counts within the region. The CALIBration constants are used to determine the energy.

4.12 ROI Command

The ROI (Region Of Interest) command is used to enter, examine, change and delete ROIS. There is a maximum of 30 ROIS in each memory sector and they can have overlapping channels.

```
EXAMINE ROI# 1
   124 TO  157
```

Use the INC and DEC keys to examine all the defined ROIS. The lower line shows the beginning and ending channel for the current ROI number. To enter a new ROI enter the desired number from the keypad and press the ENTER key.

```
CHANGE  ROI# 1
   124 TO  157
```

To change the beginning or ending channels for a ROI, first enter the desired ROI by using the keypad or by the INC and DEC keys and press the ENTER key. Next enter the new beginning channel and press the ENTER key. Last enter the new ending channel and press the ENTER key.

```
ENTER   ROI# 4
   157 TO    0
```

To enter a new ROI, select the number from the keypad and then press the ENTER key. Set the beginning channel to the desired channel by using the keypad or by the moving the cursor, then press the ENTER key. Next set the ending channel to the desired channel, then press the ENTER key.

```
CLEAR ROIS ?
```

Press the YES key to clear all the ROIS.

SEARCH FACTOR
= 4

Select the desired search factor, by using the keypad. The peak search scans two windows across the spectrum. The lower energy window contains the background. A peak is located when the higher energy window is greater than the standard deviation times the SEARCH FACTOR plus the lower energy window.

PEAK SEARCH ?

To start a PEAK SEARCH Press the YES key. Peaks located are entered into consecutive ROIS. The user may then modify any of the ROIS. With NAI detectors select the proper amount of data channels such that peaks are located properly. Some times first smoothing the spectrum using the MEMORY command gives better results.

5.1 INPUT Connector

The INPUT BNC connector is located on the right side of the MCA and is marked INPUT. Connect the output from a preamplifier or amplifier to this connector and use the SETUP command to select the proper settings to match the input signal with the internal amplifier.

5.2 High Voltage Connectors

The three SHV connectors provide a high voltage source for detectors which require it. The SETUP command controls the high voltage setting, read this section before connecting any cables.

Warning: Make sure the high voltage is off before you connect or disconnect cables from the unit.

5.3 Cutoff High Voltage Connector

Located on the side cover is a BNC connector marked CUTOFF H.V. it is used with HRG detectors which have circuitry for detecting when the liquid nitrogen runs low. A detector when cold must apply a level of -24 volts or > 10K ohms to ground and when warm a level of +5 volts or < 5 ohms to ground. The high voltage is turned off when the detector is sensed as warm.

5.4 Pole Zero test point connector

Located on the side cover is a BNC connector marked P/Z T.P. it is used to directly connect an oscilloscope to the output of the internal amplifier. The pole zero adjustment is easily made by observing the waveform see ADJUSTMENTS for additional information.

5.5 Preamplifier Power Pin Assignments

Located on the right side of the unit is a 9 pin female connector called PREAMP PWR it provides the plus and minus 12 volt power, optional plus and minus 24 volt power required by low power preamplifiers in some detectors. Also, it contains the inputs for the thermistor for Americium doped NAI detectors for temperature stabilization.

PIN #	NAME
1	GROUND
2	GROUND
3	NO CONNECTION
4	PLUS 12 VOLTS
5	THERMISTOR, ACTIVE
6	MINUS 24 VOLTS OPTIONAL
7	PLUS 24 VOLTS OPTIONAL
8	THERMISTOR, RETURN TO GROUND
9	MINUS 12 VOLTS

The maximum current from the plus 12 volt supply added to the maximum current from the plus 24 volt supply must be less than 25 MA..

The maximum current from the minus 12 volt supply added to the maximum current from the minus 24 volt supply must be less than 25 MA..

It is recommended to use the SETUP command to insure that the plus and minus 12 volt supplies have not dropped in voltage as an overload might do.

5.6 RS-232-C Serial Port

The port is located on the right side of the MCA. It is a 25 pin female connector called I/O RS232. The I/O command sends and receives serial data from this port. A printer, terminal or computer may be interfaced using the standard RS-232 connections and cables. A modem maybe used if a special cable is made up.

PIN #	NAME	INPUT/OUTPUT	
1	PROTECTIVE GROUND		
2	TRANSMITTED DATA	INPUT	
3	RECEIVED DATA	OUTPUT	
4	REQUEST TO SEND	INPUT	NOTE 1
5	CLEAR TO SEND	OUTPUT	NOTE 1
6	DATA SET READY	OUTPUT	
7	SIGNAL GROUND		
8	DATA CARRIER DETECT	OUTPUT	NOTE 2
11	PRINTER HOLD	INPUT	NOTE 3
20	DATA TERMINAL READY	INPUT	

NOTE 1: Pins 4 and 5 are connected together in the MCA.

NOTE 2: Pin 8 has a 4.7K ohm resister to +5 volts.

NOTE 3: Pin 11 is a nonstandard pin it is used by high speed printers to stop I/O when their buffer is full. When the voltage on this pin is between 3 and 12 volts the MCA does not send or receive data from the port.

5.7 External Display and Plotter Connector Assignments

This connector is located under the side cover on the right side of the unit. Remove the two screws and cover to gain access to the 15 pin female connector. A larger external display requiring X/Y and intensity can be connected or it can drive an X/Y plotter.

PIN #	NAME	ACTIVE LEVEL
1	PLOTTER SEEK	LOW FOR SEEK, +12 FOR IDLE
2	INTENSITY	GND FOR BLANK, +4 FOR LOW, +5 FOR HIGH
3	INTENSITY	+12 for BLANK, +3 FOR LOW, GND FOR HIGH
4	+Y	1 VOLT PEAK TO PEAK
5	-Y	1 VOLT PEAK TO PEAK
6	ANALOG GROUND	
7	-X	1 VOLT PEAK TO PEAK
8	+X	1 VOLT PEAK TO PEAK
9	PLOTTER ENABLE	LOW ENABLED, +12 FOR DO NOT PLOT
10	PLOT COMPLETE	+3 to +12 FOR ADVANCE TO NEXT POINT
11	GROUND	
12	GROUND	
13	GROUND	
14	GROUND	
15	GROUND	

6.1 Location of Adjustments

The operational adjustments are located on the right hand side of the MCA. To gain access remove the side cover with the two screws. Use only a trimmer adjustment tool for the adjustments. Replace the side cover when finished.

6.2 Amplifier Adjustments

The four amplifier adjustments are located on the amplifier board. Looking into the side of the MCA this board is the first from the left. The adjustments are of the ten turn trimmer type.

6.2.1 NAI Pole/Zero Adjustment

The Pole/Zero adjustment for NAI (P/Z NAI), 1 uSEC time constant is the lowest trim pot on the amplifier board. First select the approximate amplifier settings using the SETUP command. Then connect an oscilloscope using a BNC to BNC cable to the P/Z T.P. connector. If available use a signal clipper as shown on the next page. Turn the BLR adjustment fully clockwise to reduce the effect of the baseline restorer (6.2.3). Place a source such that the count rate is about 200 to 300, and trigger the oscilloscope on the leading edge of the signal. Next turn the adjustment and observe the trailing side of the pulses, near the baseline, reduce the VOLTS/DIV on the oscilloscope for more detail. The proper Pole/Zero adjustment is made when the pulse returns to the baseline with no under or over shoot in a minimum time.

6.2.2 HRG Pole/Zero Adjustment

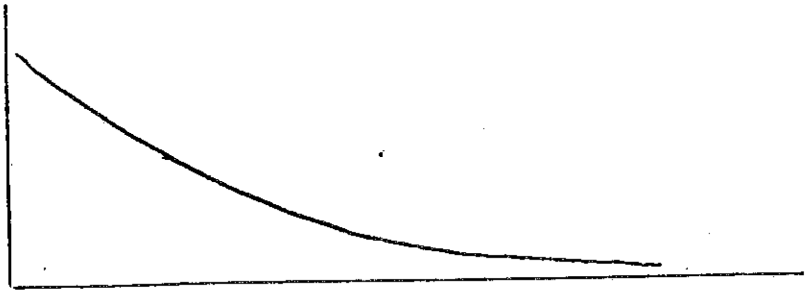
The Pole/Zero adjustment for HRG (P/Z HRG), 3 uSEC time constant is the second trim pot from the bottom on the amplifier board. Use the same procedure as NAI Pole/Zero Adjustment.

6.2.3 Baseline Restorer Discharge Current Adjustment

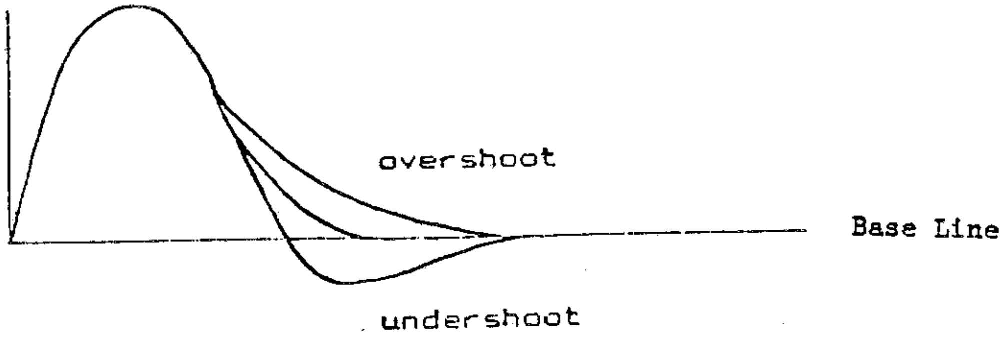
The Baseline Restorer Discharge Current adjustment (BLR) is the top trim pot on the amplifier board. Turn the adjustment fully clockwise and check the Pole/Zero setting. Next place a source by your detector with a count rate of about the highest you expect turn the adjustment counter-clockwise until the baseline returns to its proper level.

6.2.4 Baseline Restorer Zero Voltage Adjustment

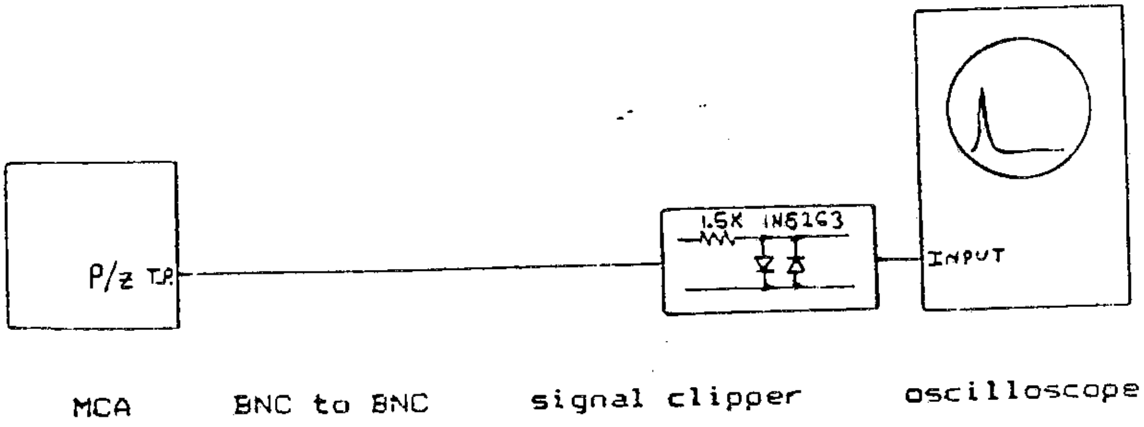
The baseline Restorer Zero Voltage adjustment is the second trim pot from the top on the amplifier board. Connect an oscilloscope to the P/Z T.P. connector. Disconnect the detector cable from the INPUT connector and trim the pot for zero volts.



Signal from preamplifier



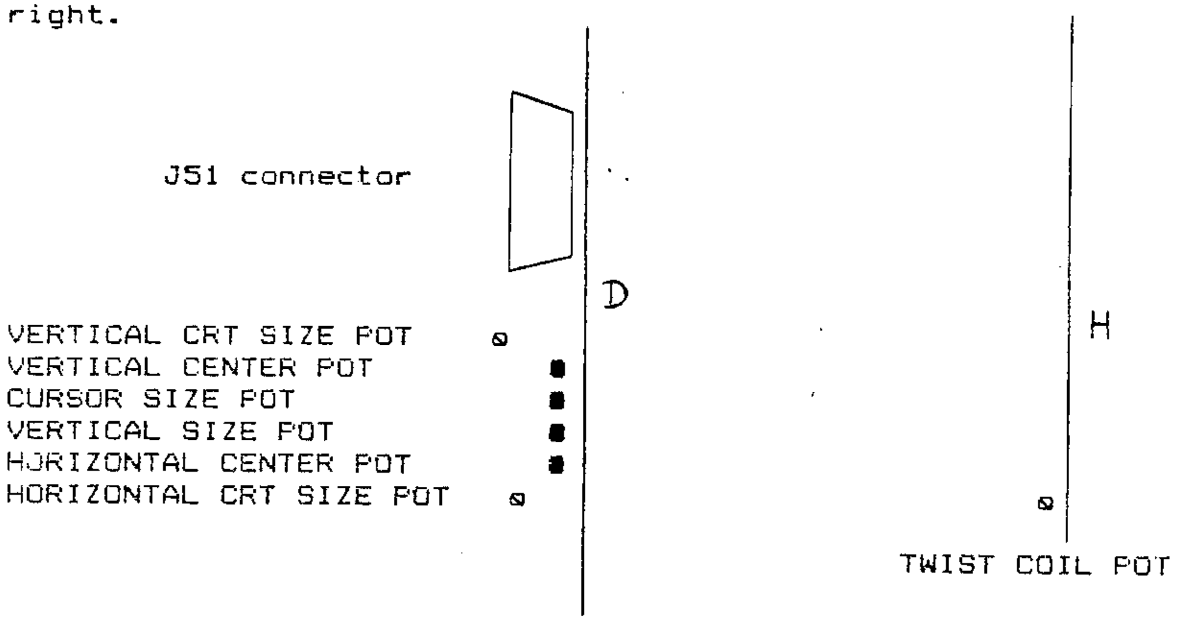
Amplifier output



Setup for POLE/ZERO adjustment

6.3 CRT Display Adjustments

The CRT Display Adjustments are preset at the factory, only adjust them when necessary. Six adjustments are located on the display board fourth from the left, and one is on the high voltage board (Remove HIGH VOLTAGE module) first on the right.



6.3.1 Vertical Adjustment for CRT Display

Collect a spectrum which overflows when the FULL SCALE knob is on 256. Use an oscilloscope to observe the waveform on pin 4 of connector J51 on the display board. Adjust the VERTICAL SIZE POT for a 1 volt signal level. Next adjust the VERTICAL CENTER POT and VERTICAL CRT SIZE POT for proper display on the CRT.

6.3.2 Horizontal Adjustment for CRT Display

Turn the EXPAND knob counter clockwise to its end position and the POSITION knob such that its white line is straight up (front panel knobs). Adjust HORIZONTAL CENTER POT and HORIZONTAL CRT SIZE for a proper display on the CRT.

6.3.3 Cursor Size Adjustment for CRT Display

Adjust the CURSOR SIZE POT for a small size line above the cursor channel.

6.3.4 Twist Coil Adjustment for CRT Display

Adjust the TWIST COIL POT until the CRT trace is parallel to the CRT bezel. If the adjustment can not be made rotate the two wire connector on the opposite side of the board.

6.4 Stabilizer Adjustments

The two stabilizer adjustments are located on the C board fifth from the left side of the MCA. The adjustments are the ten turn trimmer type.

6.4.1 Stabilizer GAIN Adjustment

The lower of the two adjustments is the stabilizer GAIN adjustment. The purpose of this adjustment is to center the temperature range within the usable range of the detector. Set the HIGH VOLTAGE to the recommended nominal voltage and keep the detector at some fixed middle temperature (20°C). Using the SETUP command turn the stabilizer ON and observe the error MONITOR on the next window. If the MONITOR is increasing, adjust the stabilizer gain in a clockwise direction. If the MONITOR is decreasing, adjust the stabilizer gain in a counter-clockwise direction. The proper setting is made when the MONITOR remains approximately equal to zero.

6.4.2 Stabilizer Temperature Compensation Adjustment

The upper of the two adjustments is the TEMPerature COMPensation adjustment. The purpose of this adjustment is to correct the differences alpha and gamma sources exhibit in the detector with temperature changes.

Turn the TEMP COMP adjustment to its end in a clockwise direction. Increase the temperature of the detector to 40°C and let stabilize for two hours. Place a Co-60 source near the detector and adjust AMP GAIN using the SETUP command, place the 1.33 Mev gamma peak near the upper part of the spectrum. Record the peak channel and HWHM channels.

Decrease the temperature to 5°C and let stabilize for two hours. Adjust TEMP COMP to bring the peak back to the channels recorded above.

Verify temperature tracking performance over the full temperature range. Letting the detector stabilize for one hour at each temperature.

Warning: If your detector has a maximum voltage less than 1250 volts you must make sure this voltage is not exceeded by the stabilizer over the temperature range.

7.1 External Control

An external device may virtually control all the functions of the MCA through the RS-232-C I/O port. Input to the port is monitored and when a key label is received the MCA takes action just as if the key had been pushed, for example sending "END" followed by a carriage return is the same as pushing the END key. Sending "PRINT" can be used to monitor the LCD window, allowing system status and parameters to be checked. To prevent the internal buffer of 80 characters from overflowing send "PRINT" and wait for the LCD window, when the window is received the buffer will be empty and the MCA ready. When using the TAPE command the MCA will accept input for 1 second before the tape operation begins, if "PRINT" has been properly received in this time the MCA will output the LCD window upon completion of the tape operation.

The following in addition to the key labels are recognized by the MCA:

CTRL P ($10) -Same as PRINT
CTRL E ($05) -Same as END
CTRL U ($15) -UP ARROW
CTRL D ($04) -DOWN ARROW
CTRL R ($12) -CURSOR RIGHT
CTRL L ($0C) -CURSOR LEFT
CTRL N ($0E) -Same as NEXT
CR ($0D) -Same as ENTER (Carriage Return)

"RIGHT" -CURSOR RIGHT
"LEFT" -CURSOR LEFT
"ONKEY" -ENABLE KEY BOARD (except for display keys)
"OFFKEY" -DISABLE KEY BOARD
"ONHS" -ENABLE SERIAL HANDSHAKE
"OFFHS" -DISABLE SERIAL HANDSHAKE
"UP" -UP ARROW
"DOWN" -DOWN ARROW

7.1.1 Serial Handshake

Serial handshake is used To prevent the buffer of a computer from overflowing when the MCA is sending data. Serial handshake is enabled by sending "ONHS" to the RS-232-C I/O port. Serial handshake holds off the output from the I/O command, each line is sent after a "&" symbol is received. Sending a "E" aborts I/O and the EOT line is sent. Serial handshake is disabled by sending "OFFHS".

7.1.2 Sample Software

This section provides a start for special applications using a computer. The software is written in BASIC for the EPSON HX-20 which is a portable, battery operated computer (with memory expansion unit). The application software consists of a group of subroutines which provide setup, control and data transfer. You must be able to write programs in BASIC to use this software.

```
1 GOTO 100

2 PRINT#1,"END"
3 PRINT#1,"END":RETURN
4 PRINT#1,"PRINT":LINE INPUT#2,T$:RETURN
5 PRINT#1,"INC":RETURN
6 PRINT#1,"DOWN":RETURN
7 PRINT#1,"YES":RETURN
8 PRINT#1,"NO":RETURN
9 PRINT#1,"NEXT":RETURN

50 SOUND 10,3
55 T$=INKEY$
60 PRINT
65 PRINT "PRESS SPACE";
70 IF INKEY$<>" " THEN 70
75 CLS
80 RETURN

100 CLEAR 1000
105 LOCATE 0,0,0
110 CLS
111 PRINT "POWER UP MCA"
112 PRINT "CONNECT CABLES"
115 GOSUB 50
120 CLS
121 PRINT "SET BAUD RATE=4800"
122 PRINT "SET PARITY=EVEN"
125 GOSUB 50

130 GOSUB 7150 :REM  Initialize the RS-232-C port.
135 GOSUB 7000 :REM  Initialize the MCA.
140 DIM R(30,6),H$(11),D(LC)
```

Your application program should be written for line numbers 145 to 6990. Data statements should be at line numbers 9000 and above.

```
6995 END
```

```
7000 REM  Initialize the MCA.

7005 REM  Initialize MEMORY.
7010 MD=1:MG=4:GOSUB 7195

7015 REM  Initialize SETUP.
7020 DE$="NAI"
7025 PO$="POS"
7030 GAIN=555
7035 HVPS=0
7040 ST$="OFF"
7045 LLD=12
7050 ULD=1023
7055 ZERO=0
7060 THR=40
7065 PU$="ON"
7070 GOSUB 7635

7075 REM Initialize PRESET
7080 PLT=100
7085 SM$="S"
7090 PR=0
7095 PE=999999
7100 IA$="A"
7105 GOSUB 7540

7110 REM Initialize ROI
7111 GOSUB 7480
7112 DATA 1,100,200
7113 DATA 2,400,600
7145 DATA 0,0,0
7146 READ RN,BC,EC
7147 IF EC=0 THEN 7149
7148 GOSUB 7485:GOTO 7146
7149 RETURN

7150 REM Initialize RS-232-C I/O port.
7155 CLOSE 1
7160 CLOSE 2
7165 OPEN "O",#1,"COM0:(67E1F)"
7170 OPEN "I",#2,"COM0:(67E1F)"
7175 GOSUB 2
7180 PRINT#1,"OFFHS"
7185 IF EOF(2)<>-1 THEN 7150
7190 RETURN
```

```
7195 REM  SET UP MEMORY
7200 GOSUB 2
7205 PRINT#1,"3";
7210 PRINT#1,"1"
7215 PRINT#1,MG
7220 PRINT#1,"0"
7225 PRINT#1,MD
7230 GOSUB 3
7235 IF MG=1 THEN LC=4095
7240 IF MG=2 THEN LC=2047
7245 IF MG=4 THEN LC=1023
7250 IF MG=8 THEN LC=511
7255 GOSUB 4:RETURN

7260 REM READ ROI DATA
7265 GOSUB 2
7270 PRINT#1,"ONHS"
7275 PRINT#1,"5";
7280 GOSUB 8
7285 GOSUB 8
7290 GOSUB 7
7295 FOR T=1 TO 6
7300 PRINT#1,"&";
7305 LINE INPUT#2,H$(T)
7310 NEXT T
7315 T=1
7320 PRINT#1,"&";
7325 LINE INPUT#2,A$
7330 IF LEN(A$)=0 THEN 7375
7335 R=VAL(LEFT$(A$,2))
7340 R(R,0)=VAL(MID$(A$,5,4))
7345 R(R,1)=VAL(MID$(A$,11,4))
7350 R(R,2)=VAL(MID$(A$,17,4))
7355 R(R,3)=VAL(MID$(A$,22,12))
7360 R(R,4)=VAL(MID$(A$,35,12))
7365 R(R,5)=VAL(MID$(A$,48,12))
7366 R(R,6)=VAL(MID$(A$,61,12))
7370 T=T+1: GOTO 7320
7375 PRINT#1,"&";
7380 LINE INPUT#2,A$
7385 NR=T-1:REM NUMBER OF ROIS
7390 PRINT#1,"OFFHS"
7400 GOSUB 3
7405 LT=VAL(MID$(H$(4),11,6)):REM LIVE TIME
7410 RETURN
```

```
7415 REM  ACQUIRE DATA
7420 GOSUB 2
7425 PRINT#1,"O";
7430 GOSUB 7
7435 GOSUB 7
7440 CLS
7445 GOSUB 4
7450 LOCATE 0,0,0
7455 PRINT LEFT$(T$,16)
7460 PRINT RIGHT$(T$,16)
7465 IF LEFT$(T$,5)<>"COUNT" THEN 7445
7470 CLS
7475 GOSUB 3
7477 RETURN

7480 REM CLEAR ROIS
7481 GOSUB 2:PRINT#1,"9";
7482 GOSUB 6:GOSUB 7
7483 GOSUB 3:GOSUB 4:RETURN

7485 REM  ENTER A ROI
7490 REM  RN=ROI#
7495 REM  BC=BEGINNING CHANNEL
7500 REM  EC=ENDING CHANNEL
7505 GOSUB 2
7510 PRINT#1,"9";
7515 PRINT#1,RN
7520 PRINT#1,BC
7525 PRINT#1,EC
7530 GOSUB 3
7532 GOSUB 4:REM WAIT FOR MCA TO FINISH
7535 RETURN

7540 REM  ENTER THE PRESET CONDITIONS
7545 REM  PLT=PRESET LIVE TIME
7550 REM  SM$=LIVE TIME UNITS  "S" OR "M"
7555 REM  PR=PRESET ROI
7560 REM  PE=PRESET EVENTS
7565 REM  IA$=INTEGRAL/AREA  "I" OR "A"
7570 GOSUB 2
7575 PRINT#1,"2";
7580 PRINT#1,PLT
7585 GOSUB 4
7590 IF MID$(T$,25,LEN(SM$))<>SM$ THEN GOSUB 5:GOTO 7585
7595 GOSUB 6
7600 PRINT#1,PR
7605 GOSUB 6
7606 IF PE<1E6 THEN P=0:GOTO 7610
7607 P=INT(PE/1E6):PRINT#1,P;
7610 PRINT#1,PE-P*1E6
7615 GOSUB 4
7620 IF MID$(T$,18,1)<>LEFT$(IA$,1) THEN GOSUB 5:GOTO 7615
7625 GOSUB 3:RETURN
```

```
7635 REM  SETUP COMMAND ENTRY
7645 REM  DE$=DETECTOR  "HRG", "NAI" OR "DIRECT"
7650 REM  PO$=AMP POLARITY  "POS" OR "NEG"
7655 REM  GAIN=AMP GAIN
7660 REM  HVPS=HIGH VOLTAGE
7665 REM  ST$=STABILIZER  "ON" OR "OFF"
7670 REM  LLD=LOWER LEVEL
7675 REM  ULD=UPPER LEVEL
7680 REM  ZERO=ZERO LEVEL
7685 REM  THR=THRESHOLD
7690 REM  PU$=P.U.REJECTOR  "ON" OR "OFF"
7695 GOSUB 2
7700 PRINT#1,"1";
7705 GOSUB 4
7710 DT$=LEFT$(T$,15):REM DATE AND TIME
7715 GOSUB 6
7720 GOSUB 4
7725 IF MID$(T$,10,LEN(DE$))<>DE$ THEN GOSUB 5:GOTO 7720
7730 GOSUB 6
7735 GOSUB 4
7740 IF MID$(T$,14,LEN(PO$))<>PO$ THEN GOSUB 5:GOTO 7735
7745 GOSUB 6
7750 PRINT#1,GAIN
7755 GOSUB 6
7760 PRINT#1,HVPS
7765 GOSUB 4
7770 IF LEFT$(T$,4)="TURN" THEN GOSUB 8:GOTO 7800
7775 IF LEFT$(T$,3)<>"SET" THEN 7800
7780 GOSUB 7
7785 GOSUB 4
7790 IF LEFT$(T$,7)="CONNECT" THEN PRINT#1,"NEXT"
7795 GOSUB 4
7800 GOSUB 6
7805 IF DE$<>"NAI" THEN 7830
7810 GOSUB 4
7815 IF MID$(T$,12,LEN(ST$))<>ST$ THEN GOSUB 5:GOTO 7810
7820 GOSUB 6
7825 IF ST$="ON" THEN GOSUB 6
7830 PRINT#1,LLD
7835 GOSUB 6
7840 PRINT#1,ULD
7845 GOSUB 6
7850 PRINT#1,0:REM MAKE POSITIVE
7855 PRINT#1,ABS(ZERO)
7860 IF ZERO<0 THEN PRINT#1,"SIGN":REM MINUS SIGN
7865 GOSUB 6
7870 PRINT#1,THR
7875 GOSUB 6
7880 GOSUB 4
7885 IF MID$(T$,14,LEN(PU$))<>PU$ THEN GOSUB 5:GOTO 7880
7890 GOSUB 3
7895 RETURN
```

```
7910 REM  DO A PEAK SEARCH
7915 GOSUB 2
7920 PRINT#1,"9";
7925 GOSUB 6
7930 GOSUB 6
7935 PRINT#1,4 :REM SEARCH FACTOR
7940 GOSUB 6
7945 GOSUB 7
7950 GOSUB 3
7955 RETURN

7975 REM  INPUT DATA TO EPSON
7980 GOSUB 2
7985 PRINT#1,"ONHS"
7990 PRINT#1,"5";
7995 GOSUB 7
8000 FOR T=1 TO 11
8005 PRINT#1,"&";
8010 LINE INPUT#2,H$(T)
8015 NEXT T
8020 T=0
8025 PRINT#1,"&";
8030 LINE INPUT#2,A$
8035 IF LEN(A$)=0 THEN 8085
8040 D(T)=VAL(MID$(A$,7,8))
8045 D(T+1)=VAL(MID$(A$,15,8))
8050 D(T+2)=VAL(MID$(A$,23,8))
8055 D(T+3)=VAL(MID$(A$,31,8))
8060 D(T+4)=VAL(MID$(A$,39,8))
8065 D(T+5)=VAL(MID$(A$,47,8))
8070 D(T+6)=VAL(MID$(A$,55,8))
8075 D(T+7)=VAL(MID$(A$,63,8))
8080 T=T+8:GOTO 8025
8085 GOSUB 3
8090 PRINT#1,"OFFHS"
8091 GOSUB 8095
8092 RETURN

8095 REM  ENTER HEADING INFO
8096 LT=VAL(MID$(H$(4),11,6)) :REM LIVE TIME
8097 IF INSTR(1,MID$(H$(4),11,8),"M")>0 THEN LT=LT*60
8098 RT=VAL(MID$(H$(4),30,6)) :REM REAL TIME
8099 IF INSTR(1,MID$(H$(4),30,8),"M")>0 THEN RT=RT*60
8100 DT$=LEFT$(H$(3),7)+MID$(H$(3),9,8) :REM DATE AND TIME
8105 RETURN
```

```
8110 REM  REWIND CASSETTE
8115 REM SD$=SIDE "A" OR "B"
8120 REM T$=ERROR STRING
8122 GOSUB 2
8125 PRINT#1,"6";
8130 GOSUB 7:GOSUB 4
8135 IF LEFT$(T$,8)<>"CASSETTE" THEN 8155
8140 IF MID$(T$,15,1)=SD$ THEN 8150
8145 GOSUB 5:GOSUB 4:GOTO 8140
8150 T$=""
8155 GOSUB 3
8160 RETURN

8165 REM  READ FILE
8170 REM  EP$=ENTER PARAMETERS "Y" OR "N"
8175 GOSUB 2
8180 PRINT#1,"6";
8185 GOSUB 6:GOSUB 6
8190 GOSUB 7:GOSUB 4
8195 IF LEFT$(T$,4)<>"FILE" THEN 8240
8200 FOR T=1 TO 3
8205 H$(T)=T$
8210 GOSUB 6:GOSUB 4
8215 NEXT T
8220 IF LEFT$(EP$,1)="Y" THEN GOSUB 7
8225 T$=""
8226 FILE=VAL(MID$(H$(1),5,6)) :REM FILE NUMBER
8227 ID=VAL(MID$(H$(2),21,7))  :REM ID NUMBER
8230 LT=VAL(MID$(H$(3),6,6))  :REM LIVE TIME
8231 IF MID$(H$(3),13,1)="M" THEN LT=LT*60
8235 DT$=LEFT$(H$(2),15) :REM DATE AND TIME
8240 GOSUB 3
8245 RETURN

8250 REM  WRITE FILE
8255 REM  ID=ID NUMBER
8260 REM  FILE=FILE NUMBER (0=NO CHANGE)
8265 GOSUB 2
8270 PRINT#1,"6";
8275 GOSUB 6:GOSUB 7
8280 PRINT#1,ID
8285 IF FILE<>0 THEN PRINT#1,FILE
8290 GOSUB 9:GOSUB 4
8295 IF LEFT$(T$,7)<>"WRITE F" THEN 8305
8300 T$=""
8305 GOSUB 3
8310 RETURN
```

7.1.5 DATA TRANSFER BY EXTERNAL CONTROL

The SAMPLE SOFTWARE provides data transfer of the ROIs and all the channel contents into data arrays which can be used by your application program. These transfer subroutines are descibed below.

GOSUB 7260 -TRANSFER THE ROI INFORMATION

The ROI information is transfered from the MCA to the EPSON and put into data array R(#,x) as descibed below. The number of ROIs entered is returned by the variable NR. LIVE TIME in seconds is returned by the variable LT. REAL TIME in seconds is returned by the variable RT. The current time and date are returned by the string DT$.

#=ROI# (0 TO 30)

R(#,0)=BEGINNING CHANNEL OF ROI
R(#,1)=ENDING CHANNEL OF ROI
R(#,2)=MAXIMUM CHANNEL IN ROI
R(#,3)=ENERGY OF MAXIMUM CHANNEL
R(#,4)=INTEGRAL
R(#,5)=AREA
R(#,6)=UNCERTAINTY OF AREA

GOSUB 7975 -TRANSFER THE CHANNEL CONTENTS

The channel contents are transfered from the MCA to the EPSON and put into array D(ch) as described below. LIVE TIME in seconds is returned by the variable LT. REAL TIME in seconds is returned by the variable RT. The current time and date are returned by the string DT$.

ch=CHANNEL NUMBER (0 to HIGHEST)

D(ch)=CHANNEL CONTENTS

7.1.6 MCA TO EPSON CABLE

Below is the cable connections required between the 8 pin DIN connector labelled RS-232C of the EPSON and the 25 pin connector labelled RS-232C of the MCA.

EPSON PIN#		MCA PIN#
DIN CASE	-	1
1	-	7
2	-	2
3	-	3

7.1.3 SETUP BY EXTERNAL CONTROL

The parameters used to setup the MCA are located on lines 7000 thru 7149 of the SAMPLE SOFTWARE. After determining the desired parameters insert them into the program using the editing capability of the EPSON. Every time the program is run the MCA will be setup to this state. Below is a summary of the parameters.

MEMORY COMMAND

7010	MD=1 TO MG	MEMORY GROUP
7010	MG=1, 2, 4 OR 8	NUMBER OF GROUPS

SETUP COMMAND

7020	DE$="HRG", "NAI" OR "DIRECT"	DETECTOR
7025	PO$="POS" OR "NEG"	AMP POLARITY
7030	GAIN=0 TO 16383	AMP GAIN
7035	HVPS=0 TO 5000	HIGH VOLTAGE
7040	ST$="ON" OR "OFF"	STABILIZER
7045	LLD=0 TO 4095	LLD
7050	ULD=0 TO 4095	ULD
7055	ZERO=-127 TO 127	ZERO LEVEL
7060	THR=0 TO 255	THRESHOLD
7065	PU$="ON" OR "OFF"	P.U.REJECTOR

PRESET COMMAND

7080	PLT=0 TO 65535	PRESET TIME
7085	SM$="S" OR "M"	SECONDS OR MINUTES
7086	LR$="L" OR "R"	LIVE OR REAL
7090	PR=0 TO 99	PRESET ROI#
7095	PE=0 TO 16777215	PRESET EVENTS
7100	IA$="I" OR "A"	INTEGRAL OR AREA

ROI COMMAND

7112 DATA ROI#, BEGINNING CHANNEL, ENDING CHANNEL
THRU
7144

7.1.4 CONTROL BY EXTERNAL CONTROL

The functions provided in the SAMPLE SOFTWARE are acquire data, peak search, rewind cassette, read file and write file. These control functions are to be called by your application program and are described below.

GOSUB 7415 -ACQUIRE DATA SUBROUTINE

The acquire data subroutine clears the data and places the MCA into the acquire mode. The LCD display of the MCA is echoed on the EPSON which waits for the count complete message to appear.

GOSUB 7910 -PEAK SEARCH SUBROUTINE

The peak search subroutine performs a peak search using the ROI command with a search factor of 4.

GOSUB 8110 -REWIND CASSETTE SUBROUTINE

The rewind cassette subroutine rewinds the cassette and sets the side as determined by the string SD$="A" OR "B". If no error occured the string T$="". If an error occured the string T$ is set to the error message given by TAPE command.

GOSUB 8165 -READ FILE SUBROUTINE

The read file subroutine reads the next file from the cassette into memory. The parameters from the file are entered into the MCA if the string EP$="Y" and not if the string EP$="N". If no error occured the string T$="". If an error occured the string T$ is set to the error message given by the TAPE command. LIVE TIME in seconds is returned by the variable LT$. REAL TIME in seconds is returned by the variable RT$. The data and time when the file was made is returned as the string DT$.

GOSUB 8250 -WRITE FILE SUBROUTINE

The write file subroutine writes the memory contents onto the cassette. The file number is entered by the variable FILE, when FILE=0 no change is made. The ID number is entered by the variable ID. If no error occured the string T$="". If an error occured the string T$ is set to the error message given by the TAPE command.

8.1 Service

At some time you may find that your system doesn't properly work. Your should determine the cause, such as faulty cables, the detector, peripheral equipment, a hardware or software problem in the MCA. Some times it may even be normal to the system design, the MCA is a very complex instrument.

When service is needed, first obtain a return material authorization issued by the company. Next ship the MCA freight prepaid to the company. Repack in the original container or equivalent having inside dimensions of no less than six inches more than the MCA and cushion on all sides.

For better service the instrument should have an attached note with the following:

1. Person who can be contacted and phone number.
2. Service required.
3. Exactly state where the problem is and how to observe it. Enclose tapes, listing etc..

8.2 In House Service

To service the MCA you should obtain the service manual for the MCA.

To remove the MCA from its box:

1. Turn the power off and disconnect the charger.
2. Remove the two screws and the side cover.
3. With the power turned off, remove the four screws and the high voltage module from the side of the MCA. Tuck the cable from the module into the MCA.
4. Undo the four corner fasteners on the front panel.
5. Lift the unit out by the front panel having another person disconnect the battery.
6. Undo the four fasteners holding the battery.
7. Care should be taken not to touch any high voltage source such as the back end of the CRT display, The FOCUS and INTENSITY knobs, and the HIGH VOLTAGE board.

9.1 Auto-Cycle

The Auto-Cycle option is accessed by the USER key while the command window is on the LCD. Auto-Cycle allows you to enter a sequence of key entries which can then be executed to perform a special task. The task is done once or can be repeated. The list can be generated by writing down the keys required to manually do a task and then entering them.

ENTER DATA READ
FROM TAPE ?

When using the tape to write a file, the current key list is also saved. After you read a file from tape, you have the option of using the list from that file which has been stored in a buffer. Press the YES key to move the key list from the buffer to the current list.

ENTER KEY
SEQUENCE ?

If you wish to enter a new list of keys for a task press the YES key if not press NO. NOTE: the current list is destroyed.

** ENTER KEY **
NUMBER= 0

Start to enter the list of keys the LCD will display the last key hit along with its position. The END key entered twice or 32 key entries marks the end of the list

---

EXAMINE KEY
SEQUENCE ?

To examine the current key list press the YES key. Use the down arrow to scroll through the list.

DO SINGLE
AUTO-CYCLE ?

To start the task press the YES key. When the list is finished the unit will return to the command window. To stop the task press any key not related to the CRT display.

DO REPETITIVE
AUTO-CYCLE ?

To start the task press the YES key. When the list is finished it will start again from the beginning. To stop the task press any key not related to the CRT display. The task is also stopped when the memory sector becomes one allowing you to collect up to eight spectrum.

9.1.1 Example Key Sequence

The following is an example of a task which acquires data until the preset conditions are met then prints out the ROI information. Data is collected and saved for each memory sector.

1	ACQUIRE	Enter ACQUIRE COMMAND.
2	YES	CLEAR DATA ?
3	YES	ARE YOU SURE ?
4	END	Command window.
5	I/O	Enter I/O command.
6	NO	OUTPUT ALL CHANNELS ?
7	NO	INPUT ALL CHANNELS ?
8	YES	OUTPUT ROI ?
9	END	Command window.
10	MEMORY	Enter MEMORY command.
11	INC	Increase memory sector.
12	END	Command window.
	END	End of list.

9.2 8K Data Memory

The 8K data memory option provides an extra 4K data memory which can be used to store spectra or background. When using the strip feature with an overlap of zero, spectrum are stripped using the corresponding extra data memory.

MAIN MEMORY= A

This window is added to the MEMORY command and is used to select the current main memory for acquisition, display and I/O. To change the main memory push either the DECrease or INCrease keys.

9.3 Plus and Minus 24 Volt Option

The plus and minus 24 volt option provides power for detectors which require it. The Preamplifier power connector (SECTION 5.5) supplies plus 24 on pin 7 and minus 24 on pin 6.

```
PLUS  24= 24.0V
MINUS 24=-23.9V
```

This window is added to the SETUP command and is used to monitor the plus and minus 24 volts providing the preamplifier power to a detector.

9.4 PLOT ON EPSON PRINTER

The plot option makes a low cost plot of spectra on a printer. Data files made in the field may be documented back in the lab. This provides an easy means of keeping track of data files stored on cassette tape and eliminates the need to read data files back into the MCA in the future. The USER command selects the USER programs. Push the NO key until the following appears "PLOT ON EPSON RX-80 PRINTER" then push the YES key.

VERTICAL SCALE
=LINEAR

Select the vertical scale as either LINEAR, AUTOMATIC or LOG. Linear allows you to select the full scale while automatic sets the full scale to the maximum channel.

FULL SCALE
= 200000

Select the vertical full scale.

CHANNEL NUMBERS
0 TO 400

Select the channels to be ploted by using the CUSOR knob or the keypad. A minimum of 400 channels must be used.

CS 137
SAMPLE 1

Enter a label to be printed with the plot. Use the INC and DEC keys to select the letters and the keypad to select the numbers. Push the ENTER key to advance to the next character.

START THE PLOT ?

Push the YES key to begin the plot.

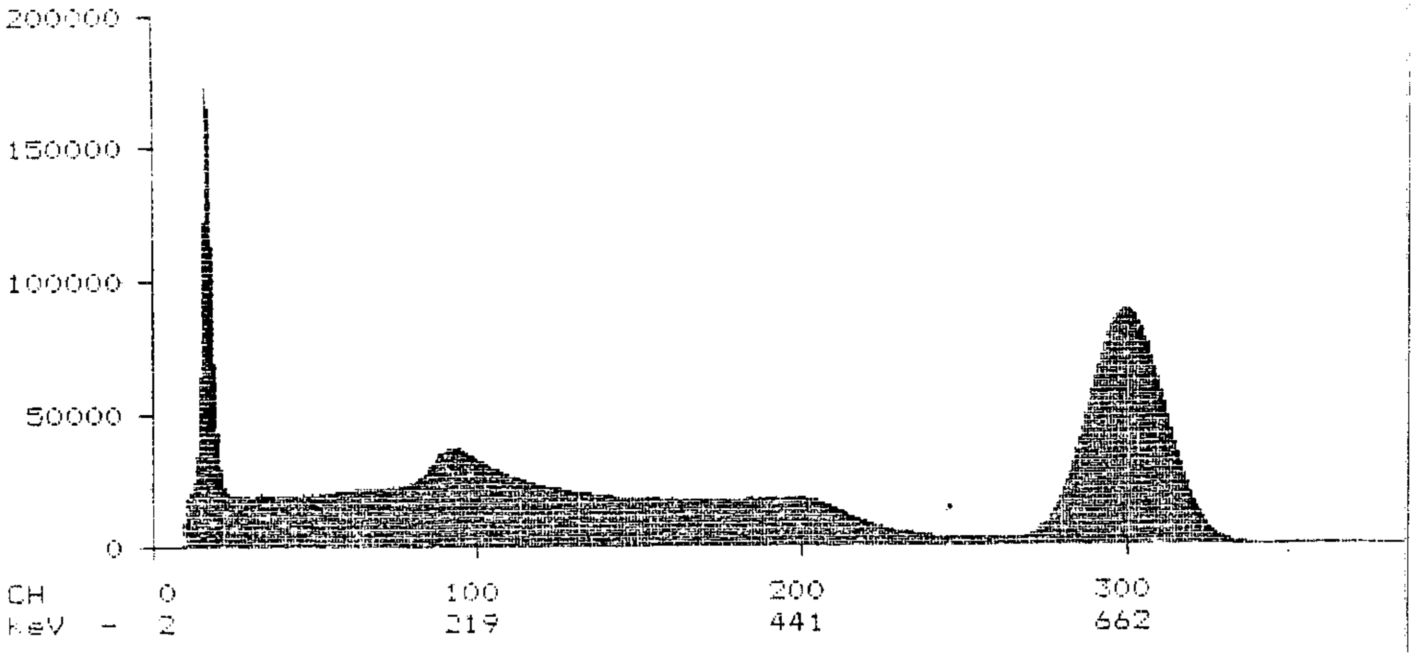
9.4.1 PRINTER AND CONNECTIONS

The printer required for the plot option is the EPSON RX-80 F/T with serial interface 8148. Install the serial interface inside the printer with the switches as shown below. Set the BAUD RATE=19200 and the PARITY=EVEN using the SETUP command. The cable should have the wires connected as given below.

SW1		SW2		CABLE
pin#		pin#		pin#
1-1	ON	2-1	ON	1
1-2	ON	2-2	ON	2
1-3	ON	2-3	OFF	3
1-4	ON	2-4	OFF	6
1-5	OFF	2-5	OFF	7
1-6	OFF	2-6	OFF	8
1-7	ON			11 *
1-8	ON			20

* PIN 11 is only required for versions 1.X see the SETUP command.

9.4.2 PLOT OF SPECTRUM FROM PRINTER



PLOT ON EPSON RX80 PRINTER

9.5 EFFICIENCY CALIBRATION

The efficiency calibration option determines the efficiency of a detector for the gamma-ray energy of each nuclide in a mixed radionuclide reference source. These values can be plotted on log-log paper to provide the efficiency calibration. Also given for each nuclide is a factor which when multiplied by the area count rate for the gamma-ray energy gives the activity in uCi for the nuclide. This option is selected by entering the user command. Push the NO key until the following appears "EFFICIENCY CALIBRATION" then push the YES key.

```
HALF LIFE
= 30.17
```

Enter the half life of the nuclide.

```
DECAY TIME
= 2
```

Enter the decay time in the units of the half life.

```
ACTIVITY IN UCI
= 5
```

Enter the original activity in uCi of the selected nuclide. If your activity is given in gamma-rays per second enter that number and then enter .000027027 for the yield.

```
CORRECTED ACT.
= 3.535534
```

The decay corrected activity is displayed.

```
YIELD
= .851
```

Enter the yield for the energy of the gamma-ray of the nuclide.

GAMMAS/SECOND
= 601302

Displays the gamma-rays per second produced at an energy by the nuclide.

SELECT ROI# 3

Use the INC and DEC keys to select the ROI which represents the gamma-ray energy of the nuclide. The ROI is to be entered by the ROI command before this option is selected.

EFFICIENCY
= .00378523

The efficiency for the detector at the energy of the gamma-ray is displayed.

FACTOR FOR UCI
= .008390281

This factor when multiplied by the area counts per second of the gamma-ray gives uCi of the source. The detector to source distance must be maintained and the source must be similar to that of the calibration.

9.6 MEASURE ACTIVITY

The measure activity option uses the factors from the efficiency calibration option to calculate the activity of up to 30 ROIs. The ROIs can be labeled as specific nuclides. The user out in the field can use this option to help determine which nuclides are in a sample and their activity. This option is selected by entering the USER command. Push the NO key until the following appears "MEASURE ACTIVITY" then push the YES key.

```
ROI# 1  CS 137
 3.968503    UCI
```

Use the INC and DEC keys to select the ROI number, observe the CRT display to inspect for a possible peak. The nuclide label for the ROI is given on the first line. The second line gives the activity and units. The window can be printed on a printer by pushing the PRINT key. To enter the labels and constants push the NEXT key.

```
ROI# 1  LABEL
CS 137    UCI
```

Enter a 8 character label for the nuclide and a 3 character label for the units. Labels are entered one character at a time by using the INC and DEC keys, push the ENTER key to move to the next character.

```
ROI# 1  CONSTANT
= .0087
```

Enter the factor from the efficiency option. This constant is multiplied by the area count rate of the ROI to obtain the activity.

ENTER THE USER
ROI LIST ?

Select the lowest number ROI and then push the NEXT key until this window appears. The ROIs entered from the ROI command are stored in a separate ROI list for use with this option. Push the YES key to enter the list.

READ DATA FROM
TAPE ?

First position the tape by using the TAPE command. Select the lowest number ROI and then push the NEXT key until this window appears. Push the YES key to read the labels, constants, units and ROIs from tape.

WRITE DATA TO
TAPE ?

First position the tape by using the TAPE command. Select the lowest number ROI and then push the NEXT key until this window appears. Push the YES key twice to write the labels, constants, units and ROIs on to tape.

TABLE OF REPLACEMENT PARTS

Battery	Power Sonic	PS-126S
Cassette Recorder	Braemar-CM600C	600-0028-414
LCD Display	Epson	MA-B956B
CRT	Brimar	D7-201GH
CRT Twist Coil	Brimar	TW-28
Keys	EAO	99-451
Key Tops	EAO	99-902.9
Power Switch	EAO	51-281.025
Printed Circuit Board Assemblies		
LINEAR AMPLIFIER		AR512
ADC "A"		AR503
ADC Control "B"		AR506
Display Control "D"		AR507
Control "C"		AR511
MPU		AR489
High Voltage		AR510
Main Power Supply		AR533
Keyboard Assembly		AR508
High Voltage Multiplier		AR520

Note: Parts not listed above are identified by standard part numbers printed on each part. These parts are available from a number of manufacturers and are generally interchangeable.